GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA



PREPARATORY EXAMINATION

2022

10842

PHYSICAL SCIENCES: CHEMISTRY

PAPER 2

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TIME: 3 hours

MARKS: 150

16 pages + 4 data pages + 1 answer sheet

PHYSICAL SCIENCES: Paper 2

10842E

X05

INSTRUCTIONS AND INFORMATION:

1. This question paper consists of 9 questions. Answer ALL the questions in the ANSWER BOOK.
   Use the graph paper on the last page to answer QUESTION 5.3.1 and QUESTION 5.3.3.
2. Start the answer to each question on a NEW page.
3. Number the answers correctly according to the numbering system used in this question paper.
4. Leave ONE line open between sub-questions, for example, between QUESTION 2.1 and QUESTION 2.2.
5. You may use a non-programmable calculator.
6. You may use appropriate mathematical instruments.
7. You are advised to use the attached DATA SHEETS.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your final numerical answers to a minimum of TWO decimal places.
10. Give brief discussions, et cetera where required.
11. Write neatly and legibly.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are given as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g., 1.11 D.

1.1 Consider the condensed structural formula:

$$CH_3COCH_3$$

Identify the name of the functional group in this formula.

A Carboxylic acid

B Carboxyl group

C Ketone

D Carbonyl group (2)

1.2 Which of the following is the empirical formula of 1,2-dichloroethane?

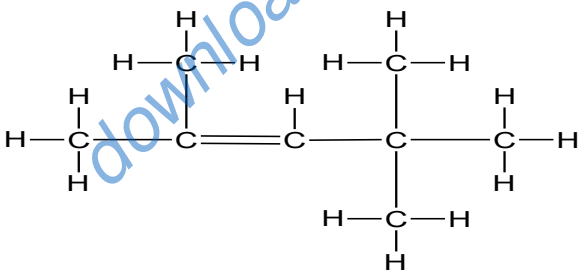
A $CHC\ell$

B $CH_2C\ell$

C $CHC\ell_2$

D $C_2H4C\ell_2$ (2)

1.3 Consider the structural formula of the organic compound below.



Which of the following statements about the above compound is CORRECT?

A 2,2,4-trimethylpent-2-ene

B 2,2,4-trimethylpent-3-ene

C 2,4,4-trimethylpent-2-ene

D 2,4,4-trimethylpent-3-ene (2)

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1.4 From the following options, choose the ONE that best explains why catalysts are so extensively used in chemical reactions:

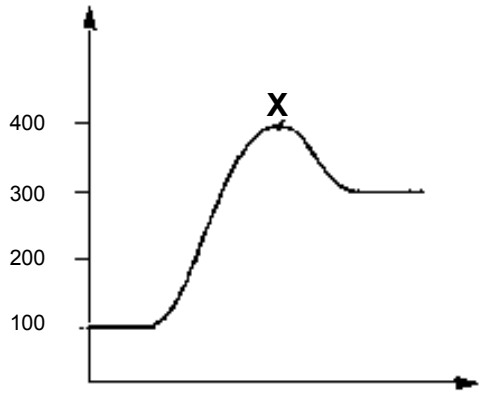
A Catalysts can be used to drive the equilibrium in the desired direction.

B Catalysts decrease the reverse reaction.

C Catalysts have no effect on the reverse reactions.

D Catalysts cause the forward and reverse reactions to proceed at a faster rate. (2)

1.5 Study the following graph and match label **X** from the following choices.



A Activation energy

B Activated complex

C Activation complex

D Activated energy (2)

1.6 The equation below represents a chemical reaction at equilibrium in a closed container.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \qquad \Delta H < 0$$

Which of the following changes will increase the yield of HI(g) in the above reaction?

A Increase in the temperature

B Decrease in the temperature

C Increasing the pressure by decreasing the volume

D Decreasing the pressure by increasing the volume (2)

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1.7 Which of the following solutions, each of concentration 0,1 mol·dm^{-3}, has the highest pH?

A $HNO_3(aq)$

B $NH_4C\ell(aq)$

C $Na_2CO_3(aq)$

D CH_3COOH (aq) (2)

1.8 A solution of ethanoic acid (acetic acid) is titrated against a standard sodium hydroxide solution. Which of the following indicators would be the most suitable for this titration?

	Indicator	pH range of the indicator
A	Phenolphthalein	8,3 – 10
B	Methyl orange	3,1 – 4,4
C	Bromothymol blue	6,0 – 7,6
D	Universal indicator	Changes colour over a wide range of pH values

(2)

1.9 Which of the following correctly gives the direction, as well as the medium, in which electrons move in a galvanic cell?

	DIRECTION	MEDIUM
A	cathode to anode	salt bridge
B	anode to cathode	external wire
C	cathode to anode	external wire
D	anode to cathode	salt bridge



(2)

1.10 Which of the following half-reactions occurs at the cathode during the electrolysis of a solution of concentrated NaCℓ?

A $2H_2O \rightarrow O_2(g) + 4H^+ + 4e^-$

B $Na^+ + e^- \rightarrow Na$

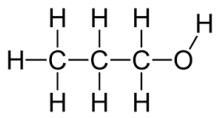
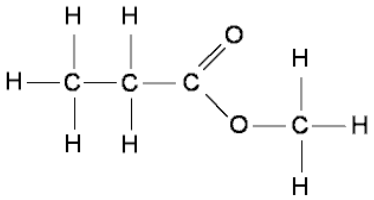
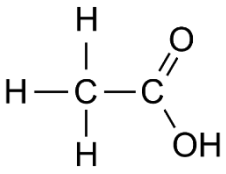
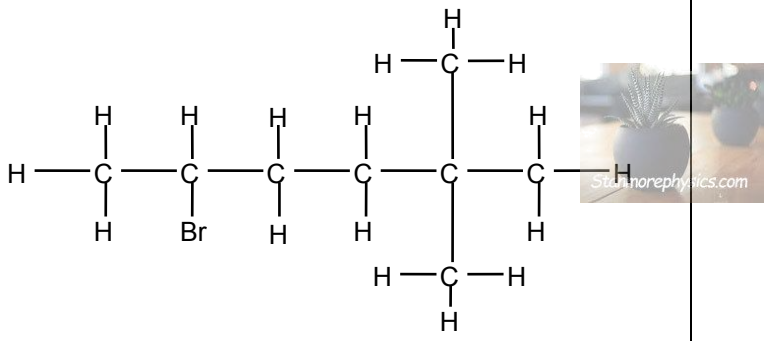
C $2C\ell^- \rightarrow C\ell_2 + 2e^-$

D $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$ (2)

[20]

QUESTION 2 (Start on a new page.)

The following types of formulae represent organic compounds. Study the table below and answer the questions that follow.

A		**B**		**C**	
D	$CH_3CHOHCH_3$	**E**	2,4-dimethylpent-1-ene	**F**	2-methylpropan-2-ol
G					

2.1 From the table above, consider compound **B**. Write down the:

2.1.1 Homologous series to which compound **B** belongs (1)

2.1.2 IUPAC name of compound **B** (2)

2.2 An alcohol and an acid are heated in the presence of concentrated sulphuric acid to form compound **B**. Write down the:

2.2.1 Role of the concentrated **sulphuric acid** in this reaction (1)

2.2.2 Names of the alcohol and the organic acid used to prepare compound **B** (2)

2.2.3 Name of the type of the reaction that is taking place (1)

2.3 From the table above, consider compound **C**.

2.3.1 Write down the name of the functional group of compound **C**. (1)

2.3.2 To which homologous group does compound **C** belong? (1)

2.3.3 Differentiate between the terms *functional group* and *homologous series*. (2)

2.4 From the table above, consider compounds **A, D** and **F**.

2.4.1 Write down the homologous series to which they belong. (1)

2.4.2 **Compound A** and **D** are isomers. As what **type of isomer** will they be classified? (1)

2.4.3 Draw the structural formula for compound **F**. (3)

2.5 Write down the:

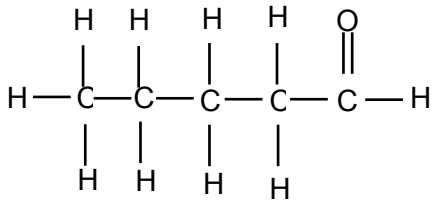
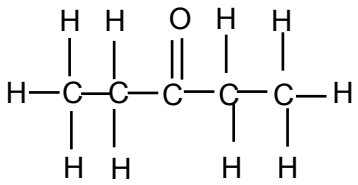
2.5.1 IUPAC name of compound **G** (3)

2.5.2 Structural formula of compound **E** (2)

[21]

QUESTION 3 (Start on a new page.)

3.1 Study the following two organic structures and answer the questions that follow.

A	B
	

3.1.1 Compound **A** and **B** are functional isomers. Define the term *functional isomer.* (2)

3.1.2 Write down the IUPAC name of compound **B**. (2)

3.1.3 How does the boiling point of **A** compare to that of the PENTAN-1-OL? Write down only GREATER THAN, EQUAL TO or LOWER THAN. (1)

3.1.4 Explain your answer to QUESTION 3.1.3 fully, by referring to the type of intermolecular forces present in each of these compounds. (3)

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3.1.5 How will the vapour pressure of compound **B** compare to that of PENTAN-1-OL? Write down only HIGHER THAN, LOWER THAN or EQUAL TO. Explain the answer fully. (3)

3.2 Learners use compounds **C** to **E** to investigate ONE factor which influences the **boiling points** of organic compounds.

C	$CH_3CH_2CH_2CH_3$	-1 °C
D	$CH_3CH_2CH_2CH_2CH_3$	36,1 °C
E	$CH_3CH_2CH_2CH_2CH_2CH_3$	69 °C

3.2.1 Define the term *boiling point*. (2)

3.2.2 Write down the independent variable for this investigation. (1)

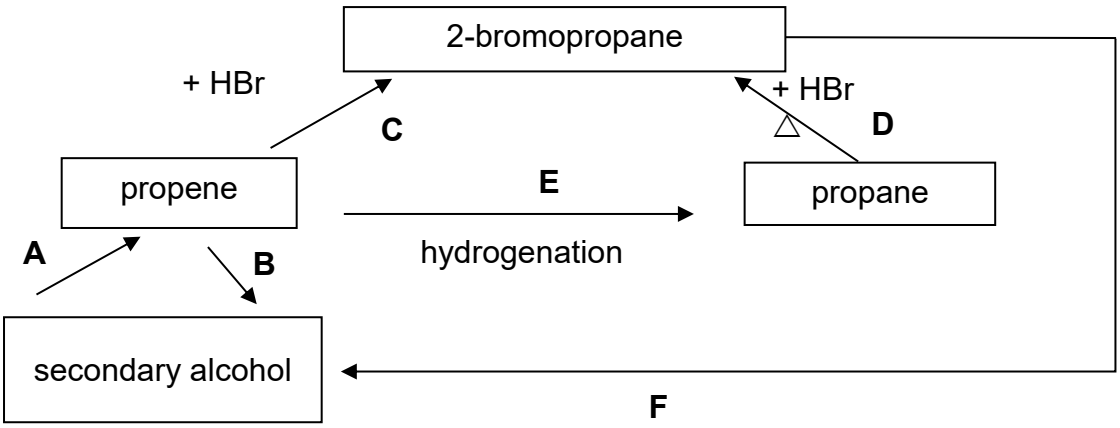
3.2.3 Write down the type of Van der Waals force that occurs between these organic compounds. (1)

3.2.4 Write down the conclusion that can be drawn about the **boiling point** of straight chain alkanes. (2)

[17]

QUESTION 4 (Start on a new page.)

Most organic compounds can undergo different reactions to produce a variety of organic compounds. Some incomplete reactions are represented below.



4.1 Consider reaction **A**. Write down the type of reaction that takes place. (1)

4.2 Reaction **B** represents a hydration reaction.

4.2.1 Define the *hydration reaction*. (2)

4.2.2 Write down the **name** or **formula** of the catalyst used for this reaction. (1)

4.3 During reaction **C**, a specific rule is followed to determine the major product when HBr is added.

4.3.1 Write down TWO conditions for this reaction. (2)

4.3.2 Use structural formulae and write down the balanced equation for this reaction. (3)

4.4 Identify the type of reaction taking place at:

4.4.1 Reaction **D** (1)

4.4.2 Reaction **F** (1)

4.5 Reaction **E** is a hydrogenation reaction.

4.5.1 Write down the TWO reaction conditions for this reaction. (2)

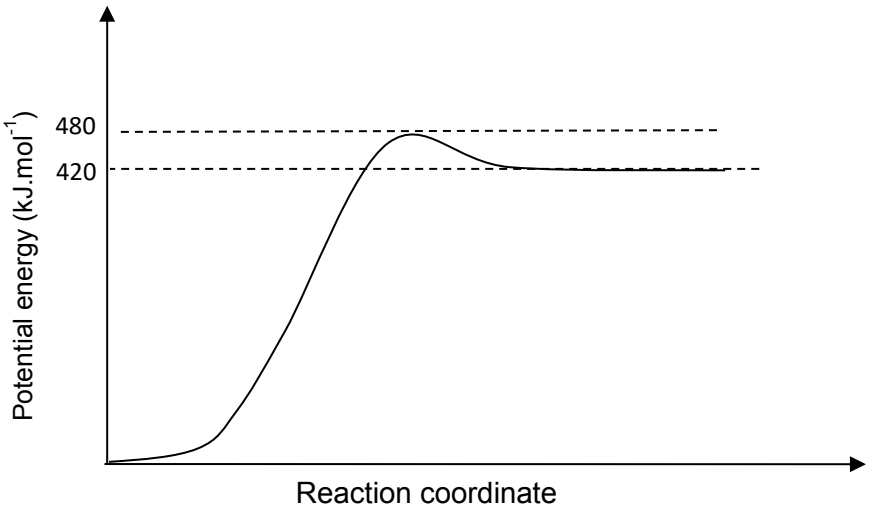
4.5.2 This reaction is widely used in industry. Name ONE use of hydrogenation in the food industry. (1)

[14]

QUESTION 5 (Start on a new page.)

5.1 The graph below shows the change in potential energy for the reaction where limestone is changed into lime. The balanced equation for this reaction is:

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

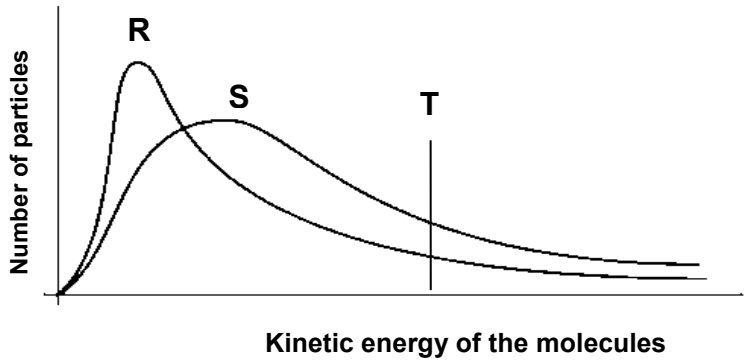


5.1.1 Is the forward reaction exothermic or endothermic? (1)

5.1.2 Calculate the heat of reaction for the forward reaction. (2)

5.1.3 Write down the activation energy for the reverse reaction. (1)

5.2 The following graph represents the number of particles against a specific amount of kinetic energy of the molecules. The data for samples **R** and **S** was obtained at different temperatures which affects the rate of reaction.



5.2.1 Define the term *rate of reaction.* (2)

5.2.2 What does the area to the right of line **T** represent? (1)

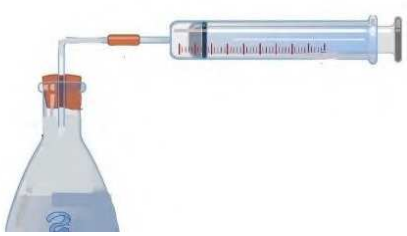
5.2.3 Which sample was at a higher temperature? Write down only SAMPLE **R** or SAMPLE **S**. (1)

5.2.4 Explain the answer to QUESTION 5.2.3 by using the collision theory. (3)

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5.3 11 g of magnesium ribbon reacts with a 0,25 mol.dm^{-3} hydrochloric acid solution at a temperature of 25 °C according to the following balanced reaction:

$$Mg_{(s)} + 2HCl_{(aq)} \rightarrow MgCl_{2(aq)} + H_{2(g)}$$



A table of the results is given below:

Time elapsed (minutes)	Volume of $H_{2(g)}$ (cm^3)
0	0
0,5	17
1,0	25
1,5	30
2,0	33
2,5	35
3,0	35

5.3.1 Use the graph paper that is printed on the last page of the question paper. Plot a graph of these results. (2)

5.3.2 Use the graph and explain what happened with the reaction between 2 minutes and 3 minutes. (1)

5.3.3 In a second experiment, the concentration of the hydrochloric acid changed from 0,25 mol.dm^{-3} to 1 mol.dm^{-3}.
Draw a new curve on the same graph paper to show what effect it will have. Label the new curve **X**. (2)

5.3.4 Assume the molar gas volume at 25 °C is 24,47 dm^3·mol^{-1}. Calculate the volume of acid that was used in the first experiment when the reaction was completed. (4)

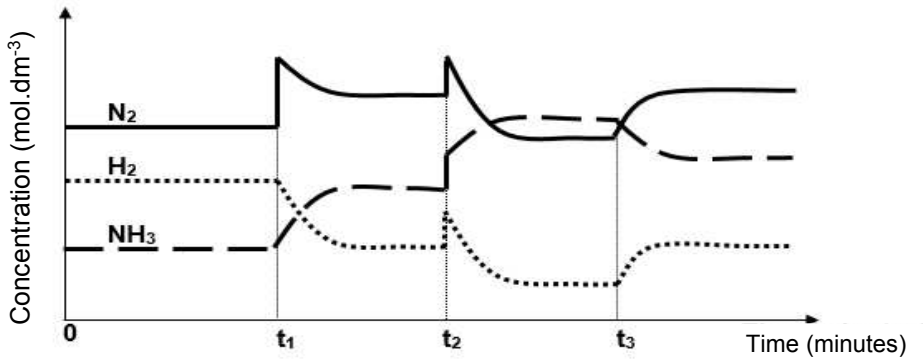
[20]

QUESTION 6 (Start on a new page.)

6.1 The balanced equation below represents the reaction that reaches equilibrium in a sealed container.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H < 0$$

To increase the yield of ammonia, adjustments are made to the temperature, pressure and concentration of the equilibrium mixture. The graph below represents the results obtained.



Identify the changes made to the equilibrium mixture at each of the following times.

6.1.1 t_1 (1)

6.1.2 t_2 (1)

6.1.3 t_3 (1)

6.2 State *Le Chatelier's principle* in words. (2)

6.3. The pressure of the reaction mixture in QUESTION 6.1 above is disturbed by increasing the volume of the sealed container.

6.3.1 How will the change above affect the yield of $NH_3(g)$? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

6.3.2 Use Le Chatelier's principle to explain the answer to QUESTION 6.3.1. (3)

6.4 5 mol N_2 and 5 mol H_2 are now sealed into a 5 dm^3 empty container. Equilibrium is reached at 450 °C. Upon analysis of the equilibrium mixture, it is found that the mass of NH_3 is 20,4 g.

Calculate the value of the equilibrium constant (Kc) at 450 °C. (9)

6.5 The temperature is now increased to 700 °C. What will happen to the value of Kc at this temperature once a new equilibrium was reached? Write down only REMAINS THE SAME, INCREASE or DECREASE. (2)

[20]

QUESTION 7 (Start on a new page.)

7.1 Define the term *acid* according to the Arrhenius theory. (2)

7.2 Consider the following acid-base reactions.

X: $HF + H_2O \rightleftharpoons H_3O^+ + F^-$

Y: $HNO_3 + NH_3 \rightleftharpoons NH_4^+ + NO_3^-$

7.2.1 From reactions **X** and **Y** identify the reaction that illustrates the Arrhenius theory. (1)

7.2.2 Write down a balanced equation for the hydrolysis of NH_4^+ ions. (3)

7.2.3 Will the resultant solution from QUESTION 7.2.2 be acidic, basic or neutral? Give a reason for your answer. (2)

7.3 A sodium hydroxide solution is prepared by dissolving 4 g of sodium hydroxide in water to make a 500 cm^3 solution.

7.3.1 Calculate the concentration of the sodium hydroxide solution. (3)

7.3.2 During a titration, 12,5 cm^3 of sodium hydroxide solution neutralises 25 cm^3 of a sulphuric acid solution according to the following balanced chemical equation:

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + H_2O(\ell)$$

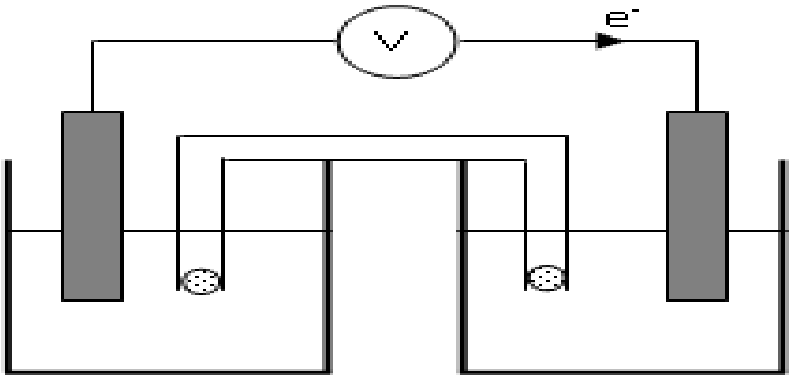
Calculate the pH of the H_2SO_4 solution. (7)

[18]



QUESTION 8 (Start on a new page.)

The galvanic cell represented in the diagram below consists of a Ba electrode dipped into a $Ba(NO_3)_2$ solution, and a Cu electrode dipped into a $Cu(NO_3)_2$ solution. Assume that the cell operates under standard conditions.



Half-cell **A** Half-cell **B**

8.1 State TWO standard conditions under which this cell operates. (2)

8.2 Which half-cell, **A** or **B** is the cathode? Write only **A** or **B**. (1)

8.3 Write down the half-reaction that takes place in half-cell **A**. (2)

8.4 Write down the cell notation for this cell. (3)

8.5 Calculate the emf of this cell. (4)

8.6 How will each of the following changes influence the value of the cell's emf, as calculated in QUESTION 8.5? Write down only INCREASES, DECREASES or REMAINS THE SAME.

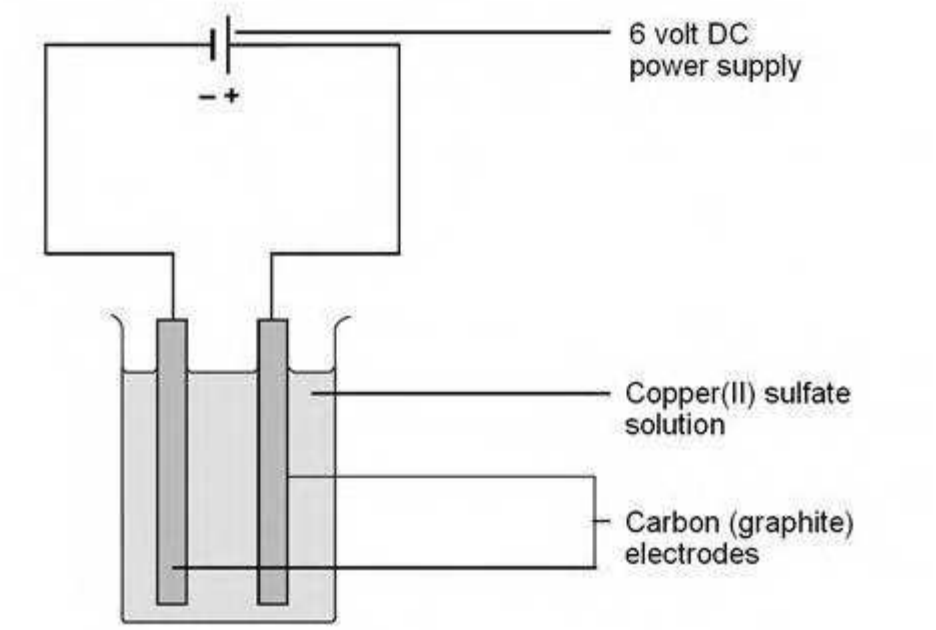
8.6.1 Ammonium sulfate is added to the barium nitrate solution. (1)

8.6.2 The temperature of the solutions is increased. (1)

[14]

QUESTION 9 (Start on a new page.)

The diagram below shows an electrolytic cell used for the refining of copper in industry.



9.1 State the energy conversion that takes place in this electrolytic cell. (2)

9.2 What will be observed at the cathode? (1)

9.3 Write down the half-reaction that takes place at the anode. (2)

9.4 What will happen to the colour of the blue copper (II) sulfate solution as the reaction progresses? (1)
[6]

TOTAL: 150

END

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

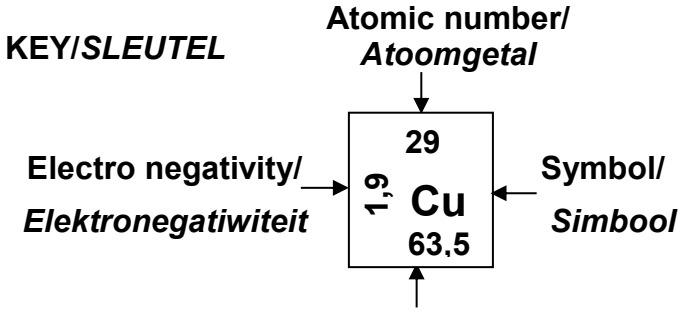
TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	p^{θ}	$1,013 \times 10^5$ Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	$22,4\ dm^3 \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K
Charge on electron *Laai op elektron*	e^-	$-1,6 \times 10^{-19}$ C
Avogadro's number *Avogadro se nommer*	N_A	$6,02 \times 10^{23}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	pH = -log[H_3O^+]
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode} / E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation} / E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ $E^{\theta}_{cell} = E^{\theta}_{oxidisingagent} - E^{\theta}_{reducingagent} / E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	

TABLE 3: THE PERIODIC TABLE OF ELEMENTS/*TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE*



1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
2,1 H 1																	2 He 4
1,0 Li 7	1,5 Be 9											2,0 B 11	2,5 C 12	3,0 N 14	3,5 O 16	4,0 F 19	Ne 20
0,9 Na 23	1,2 Mg 24											1,5 Aℓ 27	1,8 Si 28	2,1 P 31	2,5 S 32	3,0 Cℓ 35,5	Ar 40
0,8 K 39	1,0 Ca 40	1,3 Sc 45	1,5 Ti 48	1,6 V 51	1,6 Cr 52	1,5 Mn 55	1,8 Fe 56	1,8 Co 59	1,8 Ni 59	1,9 Cu 63,5	1,6 Zn 65	1,6 Ga 70	1,8 Ge 73	2,0 As 75	2,4 Se 79	2,8 Br 80	Kr 84
0,8 Rb 86	1,0 Sr 88	1,2 Y 89	1,4 Zr 91	Nb 92	1,8 Mo 96	1,9 Tc	2,2 Ru 101	2,2 Rh 103	2,2 Pd 106	1,9 Ag 108	1,7 Cd 112	1,7 In 115	1,8 Sn 119	1,9 Sb 122	2,1 Te 128	2,5 I 127	Xe 131
0,7 Cs 133	0,9 Ba 137	La 139	1,6 Hf 179	Ta 181	W 184	Re 186	Os 190	Ir 192	Pt 195	Au 197	Hg 201	1,8 Tℓ 204	1,8 Pb 207	1,9 Bi 209	2,0 Po	2,5 At	Rn
0,7 Fr	0,9 Ra 226	Ac															

58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

TABLE 4A: STANDARD REDUCTION POTENTIALS/
TABEL 4A: STANDAARD REDUKSIEPOTENSIALE

Half-reactions/*Halfreaksies*			E^{θ} (V)
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	$2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 1,51
$C\ell_2(g) + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^-$	$\rightleftharpoons$	$2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^-$	$\rightleftharpoons$	$Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^-$	$\rightleftharpoons$	Pt	+ 1,20
$Br_2(\ell) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(\ell)$	+ 0,85
$Ag^+ + e^-$	$\rightleftharpoons$	Ag	+ 0,80
$NO_3^- + 2H^+ + e^-$	$\rightleftharpoons$	$NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	+ 0,77
$O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O_2	+ 0,68
$I_2 + 2e^-$	$\rightleftharpoons$	$2I^-$	+ 0,54
$Cu^+ + e^-$	$\rightleftharpoons$	Cu	+ 0,52
$SO_2 + 4H^+ + 4e^-$	$\rightleftharpoons$	$S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^-$	$\rightleftharpoons$	$4OH^-$	+ 0,40
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	Cu	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^-$	$\rightleftharpoons$	Cu^+	+ 0,16
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	Sn^{2+}	+ 0,15
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	+ 0,14
$2H^+ + 2e^-$	**$\rightleftharpoons$**	**$H_2(g)$**	**0,00**
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	Fe	– 0,06
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	Pb	– 0,13
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	Sn	– 0,14
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	Ni	– 0,27
$Co^{2+} + 2e^-$	$\rightleftharpoons$	Co	– 0,28
$Cd^{2+} + 2e^-$	$\rightleftharpoons$	Cd	– 0,40
$Cr^{3+} + e^-$	$\rightleftharpoons$	Cr^{2+}	– 0,41
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	Fe	– 0,44
$Cr^{3+} + 3e^-$	$\rightleftharpoons$	Cr	– 0,74
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	Zn	– 0,76
$2H_2O + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-$	– 0,83
$Cr^{2+} + 2e^-$	$\rightleftharpoons$	Cr	– 0,91
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	Mn	– 1,18
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	$A\ell$	– 1,66
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	– 2,36
$Na^+ + e^-$	$\rightleftharpoons$	Na	– 2,71
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	– 2,87
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	– 2,89
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	Ba	– 2,90
$Cs^+ + e^-$	$\rightleftharpoons$	Cs	– 2,92
$K^+ + e^-$	$\rightleftharpoons$	K	– 2,93
$Li^+ + e^-$	$\rightleftharpoons$	Li	– 3,05

Increasing oxidising ability/*Toenemende oksiderende vermoë*

Increasing reducing ability/*Toenemende reduserende vermoë*

TABLE 4B: STANDARD REDUCTION POTENTIALS/
TABEL 4B: STANDAARD REDUKSIEPOTENSIALE

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↓

Half-reactions/*Halfreaksies*			E^{θ} (V)
$Li^+ + e^-$	$\rightleftharpoons$	Li	− 3,05
$K^+ + e^-$	$\rightleftharpoons$	K	− 2,93
$Cs^+ + e^-$	$\rightleftharpoons$	Cs	− 2,92
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	Ba	− 2,90
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	− 2,89
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	− 2,87
$Na^+ + e^-$	$\rightleftharpoons$	Na	− 2,71
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	− 2,36
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	$A\ell$	− 1,66
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	Mn	− 1,18
$Cr^{2+} + 2e^-$	$\rightleftharpoons$	Cr	− 0,91
$2H_2O + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-$	− 0,83
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	Zn	− 0,76
$Cr^{3+} + 3e^-$	$\rightleftharpoons$	Cr	− 0,74
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	Fe	− 0,44
$Cr^{3+} + e^-$	$\rightleftharpoons$	Cr^{2+}	− 0,41
$Cd^{2+} + 2e^-$	$\rightleftharpoons$	Cd	− 0,40
$Co^{2+} + 2e^-$	$\rightleftharpoons$	Co	− 0,28
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	Ni	− 0,27
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	Sn	− 0,14
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	Pb	− 0,13
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	Fe	− 0,06
$2H^+ + 2e^-$	**$\rightleftharpoons$**	**$H_2(g)$**	**0,00**
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	Sn^{2+}	+ 0,15
$Cu^{2+} + e^-$	$\rightleftharpoons$	Cu^+	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	Cu	+ 0,34
$2H_2O + O_2 + 4e^-$	$\rightleftharpoons$	$4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^-$	$\rightleftharpoons$	$S + 2H_2O$	+ 0,45
$Cu^+ + e^-$	$\rightleftharpoons$	Cu	+ 0,52
$I_2 + 2e^-$	$\rightleftharpoons$	$2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O_2	+ 0,68
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	+ 0,77
$NO_3^- + 2H^+ + e^-$	$\rightleftharpoons$	$NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^-$	$\rightleftharpoons$	Ag	+ 0,80
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(\ell)$	+ 0,85
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Br_2(\ell) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$Pt^{2+} + 2e^-$	$\rightleftharpoons$	Pt	+ 1,20
$MnO_2 + 4H^+ + 2e^-$	$\rightleftharpoons$	$Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^-$	$\rightleftharpoons$	$2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	+ 1,33
$C\ell_2(g) + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	$2H_2O$	+1,77
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87

Increasing reducing ability/*Toenemende reduserende vermoë* ↑

Name: _____

5.3 **Graph indicating the relationship between the volume of $H_2(g)$ and time**

